GUIDELINES FOR THE ESTABLISHMENT, OPERATION, MANAGEMENT, MAINTENANCE AND CLOSURE OF LANDFILLING SITES IN ONTARIO

Environment Ontario

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FOREWORD

These guidelines have been prepared by the Guideline Sub-Committee, L. Ficzere, Chairman; F. Iliffe, R. Dunn, and N. Borodczak, of the Committee on Amendments to Legislation and Regulation for Waste Management.

It is recognized that conditions under which waste materials are disposed of throughout the Province of Ontario differ significantly particularly when one considers urban and rural areas, and northern and southern Ontario. However, in all cases, strict adherence should be made to the minimum requirements which have been presented. It should also be borne in mind that in some instances, adherence to much higher requirements may be warranted for a particular installation. Chapters 1 to 4 of this report will permit a practical and realistic assessment of the desirable requirements to be employed at any waste disposal landfilling site, proposed or existing.

Adherence to the principles advanced in these guidelines will be required for approval by the Ministry of the Environment under Section 31 of The Environmental Protection Act, 1971. Every attempt has been made to ensure that the guidelines cover all desirable engineering practices and procedures. Nevertheless, it has been recognized that a document of this type cannot account for all installations that might be encountered. Legislation changes and advance in technologies will also necessitate changes in the content of the guidelines from time to time. The reader is therefore requested to assist this Ministry by drawing to its attention the need for any changes. Any changes or modifications to these guidelines should be submitted to the Director, MOE, Waste Management Branch.

PREAMBLE

This guideline consists of four chapters, each chapter dealing with one aspect of a particular subject matter. Chapter 1 might be considered as somewhat of an exception since it deals with the purpose and the scope of the guidelines.

Chapter 2 deals with applications for new landfilling sites. It outlines the legislative authority and information and documentation required under The Environmental Protection Act, 1971.

Chapter 3 deals with the landfilling design report. This report is the major supporting document for a landfilling application. The chapter outlines the basic content of the report and other information, data, plans and documentation which may be required in support of an application.

Chapter 4 discusses in some detail the design criteria intended for the preparation of the design report outlined in the previous chapter.

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1.0 CHAPTER 1 - INTRODUCTION

1.1 Purpose of Guidelines

a) This guideline is primarily intended to provide information to the Ministry of the Environment field services staff on procedures relating to landfilling waste disposal sites. It will also be of assistance to persons who intend to establish a landfilling site, or manage and/or operate such sites in Ontario.

b) It also clarifies the intent of Ontario Regulation 824, Section 10(1) and makes reference to the health and environmental factors that this regulation is designed to maintain.

c) The intent is to establish an engineered method of disposing of wastes in or on land without creating nuisances or hazards to public health or safety, to confine the refuse to the smallest practical area, and to cover it with earth material as necessary.

1.2 Scope of Guideline

a) The guideline represents minimum levels of performance required at any waste disposal landfilling site and discusses commonly used methods of achieving them.

b) Waste is generated by large metropolitan centres, by small communities, rural country areas, and industries. Since waste sources are diverse, the design, development and operation of each site should be relevant to its local situation. It is impractical to generalize on the techniques required at each site. These guidelines, therefore, describe the features that are intrinsic to a good landfilling operation.

c) Some items contained in this guideline may not be applicable to all sites, such as small sites in remote areas. In discussions with the Ministry prior to submitting the application for the approval of a site, it can be determined which matters are relevant to the installation and which aspects require a brief statement to indicate their inapplicability.

d) The guideline is not intended to be a complete reference work. The reader is referred to other Ministry's publications and other standard reference works for further information.

1.3 Definition of Landfilling

Section 1.20 of Ontario Regulation 824 defines landfilling as: "the disposal of waste by deposit, under controlled conditions, on land or on land covered by water, and includes compaction of the waste into a cell and covering the waste with cover materials at regular intervals".

2.0 CHAPTER 2 - APPLICATION FOR CERTIFICATES OF APPROVAL FOR LANDFILLING SITES

2.1 Legislative Authority

Authority for the Ministry to require an application for approval and to issue a Certificate of Approval, before operations can commence or continue at a landfilling site, is contained in Part V of The Environmental Protection Act, and in the regulations.

The Act provides that, in certain circumstances, a public hearing either may, or must be held.

Under Section 46 of The Environmental Protection Act, no use may be made of land used for waste disposal for a period of 25 years after the use ceases, except with the express permission of the Minister of the Ministry of the Environment.

It is recommended that those involved in presenting or processing proposals for waste disposal, study the provisions of Part V of the Act and the Regulations. The Environmental Assessment Act, 1975 may apply to certain site installations as well. Where it does apply, this guideline is still applicable since it discusses some of the material which may have to be incorporated into an environmental assessment report.

2.2 Information and Documentation to be Submitted

2.2.1 Initial Procedure

It is strongly suggested that before a formal application for a Certificate of Approval is submitted, the proponent discuss the proposed project with Regional Staff of the Ministry of the Environment.

The purpose of such a meeting would be to discuss:

a) environmental assessment;
b) the field information necessary prior to design;
c) general Ministry procedures.

Ministry staff have the obligation at this point to advise the proponent of the difficulties they foresee and which may have to be overcome before the proposed site will be considered environmentally acceptable. The final decision on whether to proceed or not to proceed with the submission of an application rests with the proponent and he may proceed to make application to the Ministry even if the Ministry's reaction might be considered to be unfavourable.

The costs of preparing detailed reports and plans, necessary for presentation to the public and the Environmental Assessment Board, may be considerable. The proponent may, therefore, find it beneficial to hold an informal public meeting before actual design commences to determine preliminary public response. The circumstances surrounding each individual case should guide the proponent on his decision.

If a public hearing is necessary, guidelines on public hearings may be obtained directly from the Environmental Assessment Board.

2.2.2 Professional Assistance Requirements

For most landfilling proposals, the applicant is advised to seek professional assistance from an engineer and/or hydrologist to develop the necessary data upon which the ultimate satisfactory landfilling site is designed. For many smaller sites, such data may be obtained from the Ministry of the Environment. Regardless of where the data is obtained the proponent's professional consulting engineer or hydrologist will still be required to make an

interpretation of the data in an effort to detail any special preventative measures which might be necessary at a particular installation. Providing the Ministry of the Environment has the sufficient background data, the applicant may not be required to carry out site evaluations and prepare an extensive report in the following instances:

a) when domestic wastes are the only wastes;

b) when the site is remote from population centres and individual water supplies;

c) where there is a minimal danger of emissions causing a hazard;

d) when a small population is to be served;

e) when a hearing is not required.

2.2.3 Required Documentation

The formal submission to the Ministry for a Certificate of Approval to cover both small and large sites should include at least six copies of a written submission along with the Landfilling Design Report.

Distribution:

The Environmental Assessment Board	3 copies
The Environmental Approvals Branch	1 copy
The Regional Office	1 copy
The District Office	1 copy

Note: If the proposed site is subject to The Environmental Assessment Act, 1975, the documents referred to herein may form part of the Environmental Assessment report required under that Act. The applicant should also determine if

additional copies or other documentation may be needed under the terms of The Environmental Assessment Act, 1975.

2.2.4 Proponent's Report and Application Forms

The application and supporting information forms must be correctly completed in proper detail.

The submission should clearly indicate how the site would be:

a) designed and developed;
b) maintained and operated;
c) used after completion (end use of the site).

2.3 Types of Landfilling Sites

The landfilling methods described in detail in these guidelines entail ultimate disposal of solid wastes by the area, ramp or trench method. It should be noted that the regulation as revised no longer includes "dumps" as a classified waste disposal site. All former "dump" sites are to be upgraded to conform with the requirements of the revised Regulation 824, Section 10.

Since a land disposal operation may handle a variety of materials, special design which may not be described in these guidelines might be necessary in special circumstances. Therefore, consultation with Ministry staff before applications are submitted is essential. Two examples are briefly described below:

2.3.1 Lagoon Disposal

Occasionally, certain innocuous liquid and industrial sludges may be disposed of on land. Generally, these sludges are placed in lagoon type structures where the aqueous portion

can be removed either by evaporation or seepage into the soil. The remaining sediment is disked or ploughed in, from time to time, as necessary. In order to distinguish one of these from a conventional landfilling site, it may be described, on a certificate of approval, as "Landfilling Site (Lagoon)".

Care should be taken to distinguish these from lagoons that are used for temporary storage only, where the wastes are ultimately disposed of at another location. On a certificate of approval, such a site may be called "Transfer Station (Lagoon)".

2.3.2 Processed Organic Waste Sites

The only sites which may, on certificates of approval, be described as "Organic Soil Conditioning Sites" are those where ultimate reclamation of deposited waste by crop nutrient uptake is contemplated. Where the site is not to be cropped for whatever reason, then an appropriate description on a certificate of approval is "Landfilling Site". The usual reason for including an organic site in this particular category is that the content of the waste deposited does not meet the criteria and guidelines for organic soil conditioning sites. In all cases, care should be taken to ensure that ground and surface water contamination does not result through the disposal of organic wastes.

Additional guidelines will be prepared covering site selection, design criteria and operational procedures for landfilling sites suitable for the disposal of sewage sludges which are unacceptable for utilization purposes.

3.0 CHAPTER 3 - LANDFILLING DESIGN REPORT

The landfilling design report should, where applicable, present information as outlined in this chapter. The design criteria are summarized and outlined in Chapter 4.

This chapter may be utilized as a guideline for content and presentation of the required information, data, plans, and documentation in the design report. The proponent's completed report need not, however, be limited to the proposed headings.

3.1 Title

- title of project
- proponent: i.e. municipality, company, etc.
- name of firm or person preparing report.

3.2 Letter of Transmittal and Authority

- from whom, to whom, and why
- authority by proponent to firm or person to undertake study and act on proponent's behalf.

3.3 Table of contents

- chapter headings, and sub-headings
- maps, graphs, illustrations
- appendices.

3.4 Summary and Recommendations

- brief results of the investigation, recommended procedures for site establishment, development, operation, management, maintenance and closure
- cost.

3.5 Introduction

- objectives
- background information
- design approach.

3.6 Waste Disposal Studies

The prime consideration here is to ensure that The Environmental Protection Act, 1971 requirements and regulations are fulfilled, (See paragraph 4.2.1).

The study should address:

- the issue of need
- alternative methods of carrying out the undertaking
- alternatives to the undertaking
- areas of natural environment that are, or may be directly or indirectly affected
- the nature and extent of the effects
- the measures that are or may be necessary to prevent, change, mitigate, or remedy adverse effects.

The waste disposal study leads to the selection of a preferred site and outlines the design features which will be used to meet the requirements of a proper landfilling operation.

3.7 Design and Development of Selected Site

3.7.1 Description of Selected Site

- Legal descriptions of the land presently or proposed to be owned and controlled by the

applicant and the specific portion of this land that is to be used for landfilling.

- descriptions of present land uses of both the applicant's land and adjoining lands. This should include uses permitted by official plans and restrictive area bylaws and class of farmland where applicable.

3.7.2 Population of Area

- existing population of area to be served
- projected population during design life
- other areas potentially servable.

3.7.3 Existing Facilities

- need
- problems with and inadequacy of existing facilities
- if a small site expansion is contempleted, outline necessary changes in disposal practices.

3.7.4 Waste Characteristics

- approximate quantities of each type of waste that will be deposited during the life of this site (types include ash, domestic, commercial, municipal, industrial, hazardous and organic waste)
- stipulate the types of wastes which may be deposited
- stipulate areas suitable for each type of waste deposition
- stipulate the type of wastes which are to be excluded from the site.

3.7.5 Site Topography, Geology, Soil Conditions, and Climatology

- indicate limitations of topography, soil conditions, geologic conditions and climatic conditions
- provide a contour plan.

3.7.6 Surface Water Hydrology

- protection of surface water in the area
- diversion of surface water around the site
- ditches for on-site runoff.

3.7.7 Groundwater Hydrogeology

- basic information on the hydrogeology of the site. This may include groundwater level, and hydraulic conductivity measurements
- information about surrounding wells and other water taking operations
- construction of exploration borings and wells.

3.7.8 Site Isolation

- location of existing and proposed homes, buildings, wells, rail lines, road and road allowances, transmission corridors for hydro cables and pipelines, lake, ponds, rivers, water courses, cemeteries, airports or any other thing which may be impacted upon by the land disposal operation
- facilities necessary for aesthetic and noise control.

3.7.9 Traffic Generated by Proposal

- existing and proposed traffic patterns for the area
- generated traffic.

3.7.10 Public Impact Considerations

- should be considered with the Environmental Assessment Act, 1975 and Regulations thereunder.

3.7.11 Site Development or Improvement

- clearing and grubbing
- construction of fire barriers
- construction of screening facilities
- roads and fencing
- buildings and utilities
- staging.

3.7.12 Leachate Control Measures and Monitoring Facilities

- (See Chapter 4)

3.7.13 Gas Control Measures and Monitoring Facilities

- (See Chapter 4)

3.8 Operation and Maintenance

- features and appurtenances to maintain an orderly operation
- outline for staged operations.

3.8.1 Method of Operation

- construction methods and procedures (specific methods and staging)
- operation of separate area for segregated material (e.g. brush, derelict vehicles, liquid waste, organic waste).

3.8.2 Waste Compaction and Cover

- source and details of cover material
- protection of cover material for winter operation
- refuse deposition and compaction procedures
- compaction of cover and frequency of covering
- planning for use of soil material within the site boundary.

3.8.3 Site Approaches and Perimeter

- fencing and signs indicating safety requirements, operating authority, traffic flow, hours of work
- maintenance of neutral zone or green belt.

3.8.4 Operational Facilities within Site

- portable container at entrance gate
- attendance shelter, office and communication facilities
- weigh bridge (if necessary)
- fire protection and fire fighting facilities
- vector and vermin control.

3.8.5. Site Staff

- review of functions
- assessment of need (number of staff)
- emergency situations.

3.8.6 Equipment

- type of equipment to be provided for depositing, compacting, and covering
- arrangement for alternate equipment
- storage and maintenance.

3.8.7 Surface Water Control

- maintenance of designed ditches
- provision for additional ditches as required
- maintenance of designed grade
- diversion from disposal faces.

3.8.8 Groundwater Control

- cut-off trenches, french drains
- under drains
- collection areas and pumping
- discharge control.

- 3.8.9 Leachate Monitoring, Collection and Disposal

- method of collection
- temporary storage
- maintenance and protection of observation wells
- establishment of suitable monitoring procedures.

3.8.10 Gas Monitoring and Control

- prescribed methods of covering and operation to minimize the effects of gas migration
- if gas control devices are to be constructed, describe continuing and long term operating procedures.

3.8.11 Records

- analyze need
- establish procedures for record maintenance.

3.9 Site Closure

- staged completion
- final cover and landscaping
- closing procedures
- adaptability of site for future needs
- end use.

3.10 Cost

- capital costs
- maintenance costs
- completion costs (cost of closing out a site).

3.11 Plans

3.11.1 General Comments

- suitable title
- name of project, municipality
- north direction
- name of designer and date.

3.11.2 Scales

- location map utilizing a scale of approximately 1 : 50,000
- map showing lots and concessions within one full lot and concession of the landfilling site
- topographic maps at a scale of 1 : 2,500 with at least one metre contour intervals
- working drawings at appropriate scales.

3.11.3 Details Required

(a) Topographic Details

- a map indicating the layout of the landfilling site;
- legal description of land for future registration of certificate of approval on land title;
- topography before commencement of operation, clearing and grubbing, excavated and final design contours;
- areas from which cover material is excavated;
- existing transportation and communication right of way;
- existing site access;
- existing watercourses and bodies of water;
- existing and proposed utilities;
- proposed access and on-site roads;

- existing and proposed structures;

- existing and proposed airports within ten (10) kilometres of the site;

- existing and proposed fencing (includes movable fencing);

- details of all sampling stations for leachate and gas monitoring system.

(b) Geological Details

- geologic materials present at the site;

(c) Hydrologic and Hydrogeologic Details

- drainage control system, including perimeter ditches, discharge points, and special devices;

- groundwater levels and hydraulic conductivity data;

(d) Demographic Details

- the name and address of the current registered owner of the site;

- details of existing and proposed land uses (plans, restrictive bylaws, etc.) within two (2) kilometres of the site;

- details of neutral zone, screening from public view;

- initial and staged development with completion date;

- the proposed ultimate use of the site and its ownership after disposal operations have been completed;

- any other information which, in the opinion of the site developer or the Ministry, will assist the public and the Ministry to properly assess and evaluate the environmental impacts of the proposal.

4.0 CHAPTER 4 - DESIGN CRITERIA

4.1 Introduction

4.1.1 Purpose

This section is intended for use as a guide in the preparation of design plans and details for a landfilling operation. Adherence to the principles presented, will lead to good design and construction. Although it is impossible to provide complete design criteria suitable for every landfilling operation, the details provided in this section will familiarize staff, consultants, officials, and the general public with sound design principles. Other publications should also be referred to for additional information.

4.1.2 Design Philosophy

A statement on design philosophy should be included in the information supporting an application for a landfilling operation. This philosophy should present an overview of the matters taken into account in the preparation of the proposal. It should answer questions such as why, when, where, and how often. It should also provide a link between the various sections in the proposal and show their interrelation. Continuity between preliminary development concepts and the ultimate intended use should also be provided in order to demonstrate the relationship between the site, its immediate surroundings, and the waste catchment basin it will serve.

Unusual problems and concepts should also be discussed. For example, the logistics of the use of impermeable liners together with leachate collection, treatment and disposal systems, may be less obvious to new staff, who may become involved in site management several years after the development, than to staff who have had the opportunity of discussing the proposal and the works with the consultant at the time

of its conception. Gas control is another example. The design philosophy will be of interest not only to persons involved in the later stages of site development, but to those who must assess the proposal before the Ministry's certificate of approval can be issued.

4.1.3 Site Development Stages

The site development stages may be part of, or inherent in the design philosophy, or they may be considered on a separate basis. In any event, plans and sketches illustrating how the site will appear at different development stages will be very helpful to the understanding of the total concept. Site appearance at regular intervals during its life (e.g. at quarter-points) as well as at critical development stages when significant changes will occur should also be illustrated.

Operations which take place during relatively short periods may sometimes be difficult to describe verbally and therefore, an illustration or model may overcome this difficulty. Concepts such as the "ramp-trench" method or the "moving-trench" method are examples where sketches are invaluable.

Three-dimensional models, with sections which can be added or removed to illustrate both the long and short term changes in the site's appearance, can also become extremely valuable.

The proponent should decide how to present the intended site development to those who may not only have a need to know but who also may be required to provide explanations to others.

4.2 Waste Disposal Studies

It is assumed, for the purposes of these guidelines that an integrated long-term refuse disposal system report has previously been prepared. It is further assumed, after reviewing the various disposal alternatives, that in order to make best use of natural resources and to protect the health of the residents, the most practicable disposal method is a landfilling operation. To determine the suitability of various sites for landfilling, a rating system is normally devised which takes into account such factors as: capacity, public health and safety, traffic patterns, public acceptability, isolation, conformity with land-use planning, availability of cover material, site hydrology, physiography and geology, cost of operation, and end use of operation.

Once this evaluation has been made and a site has been selected, then the details as outlined in this chapter should be provided. For many smaller sites, the evaluation of various solid waste management alternatives and a selection of specific landfill sites can be conducted without further exhaustive studies. This evaluation should nevertheless be made, regardless of the size of the site.

The Environmental Assessment Act, 1975, will eventually require environmental impact studies to be carried out on some solid waste disposal projects before they are undertaken. Social, cultural, environmental, economic and other factors will have to be reviewed during these environmental impact analysis. Solid waste projects are presently regulated under The Environmental Protection Act and this Act requires that public hearings be held on some projects before any Certificate of Approval can be issued. To facilitate the public hearing process a report dealing with the following topics would be extremely valuable:

- compatability and conformity with surrounding land uses;
- sufficiency of isolation and buffer zones;
- impacts upon road traffic;
- protection of public health and safety;
- protection of good agricultural land;
- physiography, geology, and hydrogeology;
- ground and surface water uses;
- availability of cover material. (usable soil volume rather than area is the criteria);
- development, operation, haulage and closure costs;
- end use;
- public acceptability.

4.2.1 Environmental Assessment

The Environmental Assessment process will include a study of both present and future waste quantities together with associated disposal needs and systems. For a major site, the study will be extensive; for a smaller site a less costly study may suffice. Studies are, however, always necessary; the site will be selected only after careful consideration has indicated that it represents the best environmental compromise. Only rarely will the site be regarded by all as the best proposal since some individuals would usually prefer the

location to be as far away as possible from their neighbourhood. Compromises are necessary on technical as well as overall environmental grounds. Some factors which may be considered are as follows:

a) Purpose of undertaking;

b) Description of undertaking;

c) Justification of the need for the undertaking;

d) Description of possible alternatives to the undertaking;

e) Alternative implementation methods for both the undertaking and the alternatives to it;

f) Geographic areas/boundaries within which the project will be undertaken, and the same for its alternatives. A well marked legible map should be included. (This may be a 1:500 scale topographical map, plus a smaller simplified version for publication purposes);

g) The environment affected, either directly or indirectly, for the alternatives mentioned in item e). This includes actual and possible effects of the various methods of carrying out both the undertaking and its alternatives. A map will be required to provide clarification;

h) Remedial measures for any adverse effects mentioned in item g);

i) Advantages and disadvantages to the environment of the undertaking and the alternatives;

j) All studies and reports prepared, in connection with the undertaking or matters related to the undertaking, by or for the proponent: list studies and reports;

k) All studies and reports in connection with the undertaking or matters related to it, of which the proponent is aware, but which are not prepared by or for him: list studies and reports.

4.2.2 Site Selection

a) Size of Area to be Served

The larger the area to be served, the greater will be the opportunity to find a good disposal area within it. Further, the greater the quantity of waste to be disposed of at a landfilling site, the lower the unit costs for waste disposal. Increased haulage costs are normally more than offset by the economies of developing and operating one site rather than several smaller sites. For these reasons, groups of municipalities, particularly in regional government situations, should be encouraged to resolve disposal problems on a collective basis.

b) Preliminary Site Appraisal

Site hydrology should be sufficiently detailed to permit an environmental evaluation of the proposed landfill and development operation on a conceptual basis. Characteristics and volume of the wastes, local ground and surface water quality and uses, etc., should be inventoried. Towards that end, water well records, published maps and reports, may be reviewed. Exploratory soil borings may be necessary to describe the type and composition of the earth materials as well as their vertical and horizontal distribution. Groundwater

studies may also be carried out to determine both the ground water quality and quantity as well as any movement patterns. It will also be necessary to estimate the distribution and concentration of the contaminant plume and its potential environmental effects on ground and surface waters.

In its review, the Ministry of the Environment will be concerned with a number of major issues. To maintain acceptable water quality it will be necessary to assess the level of contaminant discharge and to determine the need for containment and/or control or treatment. Based on the design of the landfill and the risks and consequences of failure, a suitable monitoring and contingency program will be requested. The proponent's cost evaluation of the necessary control facilities and contingency measures will indicate whether the site proposed is an economically viable operation.

c) Implementation Plans for Developing Centralized Systems

When a centralized disposal system is planned, the potential of existing sites must be reviewed. Environmentally acceptable sites may continue to operate and serve to bridge the time necessary to locate and develop a new large site. Every effort should be made to close unnecessary or unacceptable site operations in spite of public pressures to the contrary. Whether or not all acceptable sites will continue in use until their capacities are exhausted or whether they will be used on a rotational basis until each in turn is filled, is largely a matter of municipal concern. However, the latter alternative is to be preferred because it will usually result in immediate reduction in the cost of the waste disposal site.

d) Public Acceptance

The strength of public opposition is almost invariably proportional to the size of the site. Technical reasons for preferring a large or small site should not bias or prejudice engineers and technologists in any way. The public must be made aware of the problems of waste management and that the selection of a site involves making many compromises and trade-offs. The public must be presented with all the facts and, through the media and open public discussions, be given the opportunity to participate in waste management decisions. Normally an honest open forum adds to the credibility of a suitable design.

4.3 Waste Quantities and Qualities

4.3.1 Population to be Served

The following basic data, on the volume and nature of the waste anticipated from the design population and design area are to be included:

a) design period;
b) areas served - municipalities, townships, etc.;
c) population to be served through to the end of the design period;
d) waste generated for existing and design population;

By providing this data at the design stage, problems associated with the need for additional information and hearings can be eliminated. Under Section 33(a), any alteration, enlargement or extension of the waste disposal site for a population in excess of 1500 people requires a hearing. A public hearing is also mandatory if the site is to accept hauled liquid industrial wastes or hazardous wastes. This has resulted in many problems in the past which could have been eliminated if the design brief accompanying the

application had indicated all details related to population, nature of waste, and area served for the design period of the site.

4.3.2 Waste Characteristics

a) Types of Wastes

The various types of waste which may be safely disposed of at a particular site should be considered during both the preliminary and final evaluation stages. Lists of all acceptable types of wastes should be included in the report which will form part of the submissions to the Environmental Assessment Board and the Ministry's Environmental Approvals Branch. It should be noted whether a specific waste will cause any difficult operation or handling problems or exhibit any other relevant characteristics that may have to be considered.

b) Disposal Methods

The methods to be employed at the site for the disposal of each type of waste should be specified so that both the safety of the environment, site users, and site operating staff may be protected.

Those types of wastes which require special handling or treatment should be subject to haulage restrictions. The person in charge of a disposal site needs to know the time and date of arrival of these wastes so that pre-determined standard precautions and procedures can be employed and adverse environmental effects can be avoided. This also minimizes risks to site users and operating staff.

It is estimated, as a first approximation, that one acre of refuse compacted to a depth of 2 metres will be produced by 10,000 persons in any one year. The ratio of solid waste cover material volume usually ranges between

4:1 and 8:1. Although the amount of waste varies according to the size of the area, agricultural usage, population density and local industrial and commercial development, per capita daily accumulation is normally in the range of 2 kgm - 3 kgm.

4.4 Hydrogeological Criteria

4.4.1 Scope

The Ministry's present policy is to control the degradation of ground-water quality to protect both existing and potential reasonable uses of water on adjacent property. With this policy in mind the Ministry will require comments on the present uses of ground water in the vicinity of the site, and an estimate of the needs there might be for this ground water in the future. Both the quality and the quantity of water should be described. In some cases it may also be useful to address the uses of surface waters in the same context.

The Ministry will require a statement as to the impact of the proposed landfill operation on the ground and surface waters and on the uses of these waters. This statement should have some quantitative basis, even if it is, for example, only a crude approximation expressing the minimum amount of dilution which would be available for contaminants leaving the disposal site. Sites which cannot be evaluated in quantitative terms, with the resources available are unacceptable.

4.4.2 Topography

Some landforms do not readily lend themselves to landfilling. However, there are many valid reasons why a variety of different and difficult landforms should be considered, even though the operation may be expensive. The reasons for such a choice are discussed elsewhere.

Where adequate quantities of soil are not available on-site, cell and final cover may have to be imported, often from a considerable distance and at great costs. Nevertheless, sites with a minimum amount of soils are often considered because they are damaged lands and their reclamation may have the greatest acceptability.

Marshland as an example is often not considered although drainage may render it usable. Disruption of plant and animal life may, however, cause unacceptable ecological impacts.

Due to the demand for farmland conservation, pits, quarries and ravines are being increasingly considered as potential waste disposal sites. Development, in such cases, must protect groundwater from contamination and therefore, special engineering designs will generally be necessary to achieve this.

The hydrogeologic report in support of the application must discuss in detail critical areas, describe additional data requirements, suggest final contaminant control, outline the monitoring facilities, and discuss any contingency plan that must be associated with proper operation.

Sufficient technical data should be provided to demonstrate the feasibility of the project but not necessarily to permit final design.

4.4.3 Surface Water Hydrology

Surface waters arising either from inside or outside of the site, should be diverted from the actual disposal area.

Preventative measures will include ditches and swales around sites and adjacent to on-site roads. Disposal areas

should be graded to permit drainage; otherwise, collecting sumps and pumping stations may be necessary. It is advisable that special non-clogging pumps and appropriate screens be selected. Since the pumping facilities may become a long term installation, this concern should be addressed in the original design.

Final cover will not entirely prevent surface water infiltration.

4.4.4 Groundwater Hydrology

a) Introduction

At sites in Ontario the processes of dilution and dispersion are the principal physical mechanisms for leachate attenuation. These mechanisms must be fully explored at all potential sites.

The attenuation mechanisms of the site should be considered before any mechanical systems are designed. In fact, if the site does not lend itself to prevent off-site groundwater pollution, other alternative sites should be investigated.

To investigate the groundwater flow regimes, instrumentation such as piezometers and stand-pipes must be strategically located within and around the site.

b) General

The extent to which groundwater may be contaminated by a landfilling operation is influenced by the type, composition, and sequence of underlying and adjacent soils or geologic materials. Of particular importance is the hydraulic conductivity of the geologic materials and the types of openings (fractures or intergranular pores) through which the groundwater moves.

Sound engineering principles require that in most cases, when the local groundwater system contains potable water, factors of safety that ensure its continued potability should be adhered to.

Groundwater protection may be proposed through the use of liners. However, these should normally be used only when no alternative is available and only when a well designed and closely supervised monitoring system can be provided. A liner that has failed may produce severe environmental problems which are very difficult and expensive to correct. A number of materials such as asphalt, polymeric membranes, treated soils, etc., have been proposed in the past. It should be pointed out that their use is relatively expensive, and the long-term chemical effects of leachate on these materials is not known at this time. Underdrains are often necessary for monitoring purposes.

i) Clay Liners

Preferably natural clay soils should be used as liners. The most important consideration for any liner is in situ permeability. Therefore, the first consideration in developing the design of a suitable containment system, is to determine permeability and optimum moisture content of the proposed clays by a standard laboratory method. If this permeability is acceptable, if it can be reproduced in the field, and if the integrity of the liner can be maintained, satisfactory performance is assured. Failure of a clay liner might result from drying, shrinkage or punctures.

Factors to be considered in the design of a clay liner should include:

- compaction and the resultant hydraulic conductivity of the clay;

- whether or not drying out of the clay will occur;

- type of wastes to be placed over it and hence the leachate composition;

- nature of the clay itself, including its mineralogy and structural and microstructural arrangements;

- the depth (thickness) of the clay liner;

- if the liner's purpose is to reduce leachate discharge, the amount of leachate that will pass through the liner and how much will be collected above it;

- if the liner's purpose is to reduce groundwater inflow, the amount of inflow that will occur;

- if the liner's intention is to attenuate contaminants, as well as to provide a barrier to fluid flow;

- since most lined sites collect leachate above the liners, the method by which the leachate will be collected, treated and disposed of.

Obviously investigation, design and verification of clay liner proposals should be executed by experts having considerable familiarity with the phenomena involved.

ii) Local Soil Liners

Earth liners may be fine textured local soils with low permeability or they may be special clays such as bentonite. Special precautions taken during base preparation will prevent cracking, settling, and damage by roots and

burrowing animals. Since the earth liners' physical properties may be changed by chemical reactions between themselves and the leachate, this should become an important design consideration to maintain liner integrity.

Liners will necessitate collection and treatment of leachate. This is discussed in paragraph 4.5.

4.5 Leachate Migration, Control and Collection

The products of waste decomposition are methane, carbon dioxide, smaller amounts of hydrogen sulphide and other substances that are water soluble. The water soluble substances, in solution, are known as leachate. Their rate of formation is proportional to the amount of oxygen and water present.

"Leachate" is produced when waste material comes into contact with water at all landfilling sites. As leachate moves, the concentration of contaminants is reduced or attenuated by natural processes. If these processes are not adequate, leachate control facilities must be provided. Estimates of adequacy of natural attenuation form a basis for decision as to the need for containment control measures. Control of leachate is required when it is determined that uncontrolled releases of leachate may have a detrimental effect on groundwater quality rendering its present use impractical. Normally, leachates should be kept in as concentrated state as possible prior to treatment.

The three major processes in attenuation by natural means are:

(1) biological decomposition - breakdown of organic components by bacteria and other microorganism;

(2) dilution - mixing of contaminated water with uncontaminated water;

(3) chemical processes - chemical reactions which immobilize contaminants or slow down their movement.

These three complex processes may be assessed qualitatively; quantitative evaluations are very difficult particularly for biological decomposition and chemical processes and subject to considerable uncertainty. A careful discussion of the details of the attenuation process should therefore be included and discussed in the design report.

There is a risk that a change in pH levels in groundwater may permit the release of contaminants. In addition once soil attentuation limits have been reached, the contaminants will move with the groundwater untreated. If cropping is used, the disposal of the vegetation might present a problem.

The logistics of a proposal suggesting the collection and recirculation of leachate by spraying over previously landfilled areas should be carefully examined. In theory, the quantity of leachate to be treated would increase to unmanageably large quantities because surface water would continually be added. If there is no apparent increase, then this suggests that leachate has probably by-passed the interception facilities and has reached the groundwater system or has been lost by evaporation. Advocates of such schemes argue that leachate is attenuated in a natural manner and that odors will not be unacceptable. Such proposals should be reviewed to determine if natural attenuation can be provided. It appears that there is little doubt that quantities of leachate will progressively increase unless the leachates are made intentionally or otherwise to by-pass the interception system.

Leachate is usually collected by buried tiles, french

drains, or collection wells. These may be located under, around or down gradient from the site. Collection facilities may be above or below the water table depending upon the site characteristics. Leachates may be treated at a sewage treatment plant after discharge to a sanitary sewer. Proposal to discharge leachates to a storm sewer should only be accepted if adequate treatment systems are provided to render the leachate acceptable for discharge to a natural watercourse. Such leachate collection facilities are subject to Section 42 of The Ontario Water Resources Act and therefore require the submission of separate applications and approval prior to construction. As a general rule, unless it is absolutely unavoidable, it is better not to collect and treat leachate.

If treatment at a sewage treatment plant is not considered practical, on-site collection and treatment must be considered. Since chemical precipitation is the most important control method, the chemical composition of the leachate must be known and established and a proven treatment method must be available before approval to discharge the treated effluent to a sanitary or storm sewer can be given. Care should be taken to ensure that the leachate will not adversely affect the proper operation of the sewage treatment plant. In some instances, it may only be practical to collect the leachate for trucking to a suitable treatment facility.

A contingency plan must be available, particularly at large sites, for the collection and treatment of leachates. Sometimes under actual operating conditions, the movement of leachate and landfill gases may be different to that predicted during the theoretical design of the landfilling site. When such deviations from design can lead to unacceptable environmental consequences, a contingency plan is required to prevent environmental degradation.

Monitoring facilities should be developed to provide an advance warning of the need to implement the contingency plan. The sampling locations should be sufficiently close to the site to allow the detection of critical contamination levels soon enough to ensure that proper contingency plan measures can proceed in time to prevent any environmental problems.

The most common monitoring devices are well points. A screened, or perforated pipe is installed in a special boring, and samples are extracted for analysis to determine contaminant concentrations. In complex hydrological situations, many such well points may be necessary. Tiles, lysimeters, surface water bodies, springs, or nearby wells may also be used for monitoring purposes.

Sampling frequency is based on the rate of movement of the contaminants. Groundwater velocities are usually much less than those of surface waters, and therefore the sampling intervals might, on occasions, be longer. Monitoring parameters and frequency of sampling are site specific. Normally it may be necessary to select several parameters as indicators of contamination.

4.6 Gas Generation and Control

4.6.1 Properties of Methane

Gases emanating from landfilling sites may contain more than 50% methane. Air containing 5% to 15% methane forms a highly explosive mixture. Being lighter than air, this gas tends to rise. It is not, however, toxic by itself.

Methane gas production will normally reach a maximum about two years after placement of garbage, and this rate of production may continue for ten years. The production of methane gas may continue for centuries at various rates which are difficult to predict.

4.6.2 Methane Movement and Effects

Under some circumstances methane may migrate laterally. Together with carbon dioxide, it may displace air from around tree roots and cause the trees to die by suffocation. Therefore, if trees are to be protected, adequate ventilation must be provided. Dying trees may serve as an early warning system. Surface vegetation, with shallow roots, is normally not affected.

Vertical movement of gases is often obstructed by saturated soils, clay cover, snow and ice. Methane migration is dependent upon:

a) The permeability to methane of the medium through which it passes;

b) the type of permeability, e.g., fractures, inter-granular spaces, etc.;

c) the type of material which bounds the garbage area, and their juxtaposition, both vertically and horizontally;

c) the amount of gas and the pressure gradients involved.

Gas escape routes may be constructed as the landfilling proceeds. This is particularly true at large disposal sites. Estimates of anticipated maximum gas generation rates should be made to ensure that the gas venting components are appropriately sized. It is important where buildings are encountered or are expected to be constructed adjacent to site boundaries, that two independent protective devices be provided to guard against methane migration.

The first control measure should attempt to prevent methane leaving the disposal site: the second should prevent

any residual escaping methane from entering buildings. Closed rooms, interstices and basements are all locations where methane gas can accumulate and simultaneously where electric circuits, gas heating systems, smokers, and even shoe nails on concrete, can provide a deadly detonating spark. Even if a spark is not produced when explosive methane concentrations are developed, mortalities may still occur due to the absence of oxygen. If an active suction ventilation system is used, in or adjacent to a building, it may draw gas which might not otherwise be present into the building it is intending to protect.

4.6.3 Recovery of Methane

Since methane is an energy-rich combustible gas, it may be possible in the future to recover this resource at large sites. Methane is being recovered on an experimental basis and used as a fuel in one location in the U.S.A. At the present time, however, developers are reluctant to undertake methane gas recovery on a commercial basis. Nevertheless, it may be possible to design a landfilling site with ultimate methane recovery in mind with minimal additional costs. Since technology is in its infancy, it will not be discussed in these guidelines.

4.6.4 Gas Control

Gas control systems require special design and are therefore discussed in general only:

a) Passive System

These are systems which rely upon differences in specific gravity and temperature to permit methane and carbon dioxide to escape into the atmosphere. On large sites, intersecting gravel trenches may form a grid over and around the site.

The gravel grids and the venting stack pipes which will be projected through the final cover should be built up as the work at the site proceeds.

b) Active Systems

These are systems which rely upon mechanically operated exhaust or forced air fans.

c) Lateral Barriers

In addition, impervious barriers, either natural or man made or ventilating trenches may be used to prevent migration of gas in a particular direction. Stack pipe should be of sufficient height to disperse the gases and to make vandalism difficult. Wind rotated hoods that prevent blockage by objects inserted by vandals or by ice and snow should be provided.

d) Monitoring

Monitoring systems should be established that will make it possible to assess the effectiveness of the ventilation system which has been installed. Their design should take into account the local geology and the type and location of the man-made ventilation systems.

4.6.5 Protection of Structures

A comprehensive defense mechanism should be provided to protect structures constructed adjacent to landfill sites. Some protective devices may be inherent in the structure itself. The first floor may, for example, be elevated and an open ground level area underneath may be reserved for storage. Car parking might be avoided since automobile ignitions may cause explosions.

A gas detection system may be arranged to actuate a venting system. The detection system itself should be spark proof and should be checked periodically to ensure it is in proper working condition. Paved areas around the building may constitute a hazard because of their impermeability. Underground services, particularly hydro conduits, should be carefully designed to prevent methane collection and thereby minimize risks of explosion. The hazards to personnel entering underground service systems in which methane may have collected should not be overlooked.

4.6.6 Recommendations

a) A comprehensive engineering investigation should be carried out on all sites previously used for landfilling prior to any further development.

b) The designs for any underground utilities and sewers should take into account uneven settlement and the corrosive nature of the gas.

c) Consideration should be given in the design for different foundation and ground slab settlement and the possibility of varying uplift pressures.

d) The designs should provide against possible hazards from gases of garbage decomposition.

e) Adequate safeguards should be included in the design for the protection of the inhabitants.

f) Where properties may be adversely affected by a landfilling site, an attempt should be made to record this fact on the property title deeds.

g) The construction and use of water supplies and other wells should be such as to prevent gas contamination.

h) Precautions should be taken in the installation of the underground utilities and sewers to protect workers from possible explosions and asphyxiation.

i) At larger and sensitive sites, particularly, both gas monitoring and warning systems should be provided.

j) Development on sites adjacent to landfilling sites should be sufficiently removed or protected to eliminate any hazards from leachate or gas migration.

k) Where leachate and/or gas migration may affect adjacent developments, the need for gas systems should be reviewed.

l) Persons proposing to undertake works at a landfilling site should be advised of potential hazards and the probably high costs involved in their resolution.

m) Attention is drawn to the requirements of Section 46 of The Environmental Protection Act.

4.7 Site Facilities

4.7.1 Screening for Visual Impact, Noise Impact and Site Protection

a) Visual Impact

These are difficult to judge because of their subjective nature. However, the greater the number of people exposed to a visual impact, the greater is the probabllity that some objections will be raised to a minimal screening proposal. Fences, coniferous trees, shrubs and berms may all provide satisfactory abatement.

If minimal screening proposals are received, one approach might be to reserve judgement and to simply state that if objections or complaints are received when the site becomes operational, more screening devices may be required.

b) Noise Impact

In order to prevent noise travel, sound waves must be interrupted by solid barriers. The cost of installing noise barriers, such as earth berms or solid fences, may be a critical item in the viability of a site in a densely populated area.

The best control method is to review the noise levels at the source. Equipment with special noise control features may be appropriate. However, operating staff may still be required to wear ear protection devices to prevent aural damage and permanent hearing loss.

Narrow tree belts have practically no effect in reducing sound levels. A noise absorbing or reflecting surface provides the most efficient abatement. Good road surfaces and well maintained trucks, free from body rattles and muffler problems may reduce noise impacts.

In many applications, a combination of all of the above may be necessary.

c) Earth Berms

In some situations, earth berms can be constructed at little or no cost. Top soil, stripped from the immediate disposal areas may be used to construct the initial berms. Top soil stripped when a second disposal area is being prepared can be used for final cover at the first disposal area when it is completed. This process may be continued during the development of the site. Finally the earth berms can be removed to provide cover over the last disposal area. Care should be taken not to interrupt the drainage patterns.

d) Site Approaches and Perimeter

i) Fencing and Neutral Zone or Green Belt

For economic reasons, fences are often located adjacent to the landfilling area rather than at the edge of the certified site. The area between the boundaries of the site and the landfilling area is the neutral zone or green belt. This is owned and maintained by the site operator or owner. The neutral zone between the actual disposal area and the property limit should be at least 100 metres wide.

ii) Gates

Normally landfilling sites are fenced and gated to control vehicular access. Fencing is also employed where vandalism and scavenging is a problem. If a chain is used at the site entrance to restrict vehicular access, warning

signs should be placed at intervals on the access road and on the chain to warn snowmobilers and cyclists of the impending hazard.

e) Site Location

Account should be taken of present location and the proposed location of homes, buildings, wells, rail lines, roads and road allowances, transmission corridors for hydro, cables, pipelines, lakes, ponds, rivers, watercourses, cemeteries, airports and any other structures or situations existing or anticipated which may have impact on the proposal.

f) Truck Washing Station

For some specific landfilling sites which may handle industrial wastes, it may be necessary to provide truck washing facilities to prevent nuisance materials from being carried out of the site. A suitable washwater handling system should also be provided.

4.7.2 Roads

a) Public Roads and Access Roads

It is the proponent's responsibility to ensure that roads leading to the site are of sufficient design to accommodate the additional traffic that the site will generate. Public impacts, such as loading restrictions, additional noise levels, and hazards to other road users are design considerations.

If the roads are not owned or maintained by the proponent, it may be necessary for him to enter into an agreement with the owners to maintain or even reconstruct roads which will be used by persons other than the owners.

"Access roads", as defined by the Regulation, are those from a public road to the site boundary. Where a control access gate is, for convenience, located within the site boundaries, the road from the property boundary to the gate is technically an "on-site road", but it should be maintained and constructed in a manner appropriate for an access road.

Both "access" and "on-site" roads should be traversible under all normal weather conditions. Whenever a site is scheduled to be opened, neither ice, snow, flood, construction, nor any other factor should hinder access. Heavy snowfalls, which do not normally occur on an annual basis, may form a valid reason for temporary road closures. A proper contingency plan should be implemented in these instances.

Both access roads and on-site roads should be cleaned of litter and wastes on a regular basis.

b) On-Site Roads

On-site roads must be traversible under all normal weather conditions. Appropriate signs should be posted to describe routes to be followed. Since road construction is expensive, proper layouts should be well thought out to reduce relocations to a minimum. Both the main disposal area and subsidiary areas for appliances, tires, scrap metals, etc. should be served by the most economical road system. The road pattern, vehicle passing facilities, and intersections should provide for a smooth traffic flow. Materials brought in as wastes, which may be suitable for road construction, should be stockpiled in convenient locations.

4.7.3 Signs

The regulation requires that as a minimum, signs should be posted for the prevention of accidents. Signs in a variety of different locations can serve many useful purposes, and they should all be neat and legible.

- At the Gate

A large sign, announcing the name of the operating authority, hours of operation, persons admitted, local regulations pertaining to its use, together with bylaw authority and fines for infringement may be desirable. Site owners can consider indicating on the sign the purpose for which the landfilling site will be used after its closure.

- At the Office

Safety procedures, including actions required in emergency, governing site staff and others who may enter the site should be posted. Emergency telephone numbers and the location of the nearest phone should also be evident. Where the employer has a legal obligation to post notices, it may be desirable to post them in several locations including the rest areas.

- On-Site Roads

Other notices along on-site roads to indicate to the public where and how they are expected to travel and the location of different disposal areas, may be necessary.

- At Disposal Faces

At the disposal faces, procedures for safety and the prevention of accidents are desirable.

4.7.4. Building and Scales

a) Attendant's Shelter, Office Hygiene and Communications.

Even where sites are supervised for a short number of hours per week, an attendant's shelter is often desirable to provide relief from summer and winter conditions. Provision for sewage disposal should be considered. If only one man is to supervise the site, the shelter should be located such that the operator can direct traffic, provide assistance, and be able to witness all disposal operations. It may be desirable to relocate the shelter from time to time as work locations change.

For a large operation, an office equipped with record maintenance facilities, flush toilets, wash basins, showers, and a water supply, may be essential. Telephones are desirable, and may be expanded to provide intercommunication with haulage vehicles in the event that they have to be diverted when site equipment breaks down.

b) Weighbridge

Accurate weight determination is not a mandatory requirement but is desirable to assist municipalities in determining and allocating costs especially when one common site serves a number of municipalities.

Cost benefit considerations will determine the desirability of installing a weighbridge. A weighbridge can provide information regarding compaction ratios, waste

to cover ratios, and site life expectancy. It should, however, be noted that the weight of one truck load bears little relation to the volume that the waste will occupy after compaction.

Since the weight of both full and empty trucks will be required, the location of the weighbridge may affect the desirable location of both the office and the layout of on-site roads and it may even affect the location of the access road.

4.7.5 Public Container System

Container at the Gate

The purpose of a container at the gate is to ensure that unauthorized dumping after hours, at the gate and along the access road does not occur. This provision has both advantages and disadvantages since it may encourage after-hour disposal, and as a result anything other than a very large container may not be sufficient. Spillage and odours in its vicinity may render it aesthetically unacceptable.

Ideally, a container should be vermin and insect-proof, and in some locations even bear-proof. Bears can cause widespread litter problems and even present a danger to on-site users.

Fires, set accidentally or by vandalism, may destroy the containers. The use of containers after-hours will increase operating costs. Normally their use is not recommended although each case should be considered on its own merits.

4.7.6 Site Cover Material

The purpose of soil cover is to control insects, rodents, leachate and gas migration and infiltration; and to maintain an aesthetically acceptable site operation. Sufficient suitable soil for use as cover material should be available at the site or at some other nearby location. Soils free of large objects should normally be used; however, almost all types of soils are suitable if applied in adequate thickness. Approximately 15 cm of compacted sandy loam is sufficient for all cell cover. The thickness of the final cover will depend upon soil type and the anticipated future use of the completed site. Approximately 60 to 100 cm of sandy loam is often recommended in these instances.

Completed areas should be covered with a final cover as soon as possible, graded to conduct water away from fill or future working areas, and seeded to promote evapotranspiration. If a clay mixture is used for final cover, it should be covered with top soil to prevent cracking under drying sunny conditions.

Final cover is not intended to prevent surface water infiltration, but to permit controlled infiltration in order that garbage decomposition into gases and leachate can proceed at a pace which will permit their dispersal into the environment at safe levels without creating adverse effects.

Both cell cover and final cover are required by regulation.

4.8 Site Development and Operation

4.8.1 Methods of Operation

Three separate construction options are available and these options may be used in combination. In all cases, every effort should be made to obtain the highest possible ratio of compacted wastes to cover. Whatever method is used, it is recommended that the slope of the disposal face be no steeper than 3 horizontal to 1 vertical. Under winter conditions, flatter slopes may be necessary. A 3:1 or 4:1 slope is suggested to ensure safety to the operator and his equipment.

a) The Trench Method

Normally used for small to medium-sized sites, this method has applications for rolling terrain where one end of a trench may be left open to provide drainage. Generally, a large machine is brought in periodically to construct enough trench to permit one year of operation.

The excavated material is re-used in the following ways:

- for final cover;
- for intermediate cover;
- to increase the depth of the trenches or for intermediate cover in an area-fill method over the top of the completed trenches;
- for temporary use in berms required to reduce noise impacts.

Wastes may be compacted in horizontal layers, but it is preferred to form a ramp at one end of the trench, as this permits compaction of successive layers of garbage prior to placement of intermediate cover. A more favourable ratio of cover to wastes can thus be achieved. Public access to the trenches should also be considered.

In areas where both collector vehicles and public or private vehicles unload wastes, a ramp disposal face and a trench disposal face could be operated simultaneously.

It may be possible, by means of movable barriers, to vary the location where the public can deposit wastes. In any event, room for several vehicles to deposit wastes simultaneously should be made available. If vehicles are to reverse up to the trench, stops must be provided in the interest of safety. If vehicles are not able to get close to the disposal location, spillages may result. It is especially important in trench situations that signs adequate for the avoidance of accidents be posted.

The applicant is advised that safety aspects of the excavation of trenches are discussed in the Ministry of Labour's "The Trench Excavation Act".

Advantages:

i) Where wastes are placed directly in the trench, the amount of blowing paper is reduced.

ii) Major equipment is required only occasionally; hence equipment costs can be lower.

iii) Since the dumping edge does not change very much, road construction and road costs are minimized.

iv) The life of the site can often be extended by using the area method over previously filled trenches utilizing previously excavated material.

v) Portable fences can be easily located, if required, in strategic locations.

Disadvantages:

i) Land may be used up relatively quickly if only one lift is possible.

ii) The method is unsuitable where rock and water levels are high.

iii) Heavy (cohesive) soils, such as clay, restrict trench excavation to the dryer months.

iv) Surface water may collect in the trench and cause operation and aesthetic problems.

b) Ramp Method

In this method, a natural or man-made ramp near the edge of the site is used as a starting point. Wastes are compacted on the ramp at a slope of about 3 horizontal to 1 vertical. The vertical height of the ramp is normally about 2 to 3 metres, but heights as great as 10 metres have been used successfully. Ramp slopes may have to be decreased to 4:1 during winter operations. Compacted waste layers should be about 45 cm thick, but 60 cm thickness may be considered where heavy compaction equipment is available. It is usually desirable to introduce wastes at the bottom of the ramp.

A ramp operation may sometimes be modified so that

operations appear to take place in a wide trench. Soil is transported from its native location on one side of the trench for use as cover material on the other. Sufficient separation of the "trench" sides is necessary for construction vehicles to work and for haulage vehicles to introduce wastes.

Note that theoretical maximum economies exist when:

a) each "cell" is rhomboidal, i.e. the length, breadth and sloping heights of the cell are equal; and
b) the ratio of waste to cover material is a maximum.

Advantages:

i) A large volume of wastes can be disposed of in a relatively small area because several compacted layers of wastes can be compacted on top of each other prior to the deposition of cell cover.

ii) Land, not usable in its present form, can be reclaimed.

iii) Costs are uniform each week since there is no large capital outlay as when trenches have to be excavated.

Disadvantages:

i) Artificial barriers may be necessary to control wind borne debris.

ii) Without close control and supervision, the active working face may tend to increase in slope and width.

c) The Area Method

This method is the only practical one when cover material is some distance away. In its most simplistic form, wastes are compacted in horizontal layers, usually this is not economical, so it is rarely done. Thus, in practice, the method will usually closely resemble a ramp method.

Advantages:

i) A large volume of waste can be disposed of, as several layers of compacted wastes can be constructed on top of each other prior to completion of cell cover.

ii) Land, not usable in its present form, can be reclaimed.

iii) Costs are uniform each week since there is no large capital outlay, as when trenches have to be excavated.

iv) The method may be used on top of a completed trench and fill site which has reached its full capacity, and so extend the life of the site.

Disadvantages:

i) Artificial barriers may be necessary to control wind borne debris.

ii) Without close control and supervision, the active working face may tend to increase in slope and width.

iii) Fill used for cover must be brought to the disposal site.

4.8.2 Daily Operation of Site

Once average daily waste quantities have been calculated, a program should be established for the operation of the site. The working face should be long enough to enable compaction equipment and haulage vehicles to manoeuvre without interference. Refuse should be deposited in the immediate vicinity of the working cell, and spread and compacted in the thickness and layers envisaged in the design report. Daily cover is to be obtained in a manner that will promote its efficient use. The day-to-day operation of the site, including such things as cells, spreading and compaction, excavating and spreading of cover material, site haul roads, drainage and refuse control, should be outlined at all the various proposed stages of operation.

4.8.3 Equipment

The site operation plan should specify the type and quantities of equipment that will be provided. The operational features and "extras" should also be stated. Careful thought should precede equipment selection. Although the proponent's first consideration is usually cost, the purchase of the cheapest equipment available will not usually result in overall economies. Each landfilling site is unique and equipment specific to its needs will result in reduced operational costs. Selection of equipment and options should take into consideration:

- features actually needed;
- type of landfilling method;
- population served and waste quantities encountered;
- future population and future methods;
- possible uses other than landfilling;
- climatological considerations.

a) Types of Equipment

i) Crawler Loaders

Bucket sizes used in landfilling usually range from 1½ to 3 cubic metres, and even 4 cubic metre buckets are occasionally used. When large objects such as cars, appliance bodies, and tree stumps are handled or crushed, multi-purpose buckets may be employed.

Specific features for waste operations include single grouser track shoes for better cutting action. Large equipment should have 3-bar semi-grouser shoes to prevent track damage during turning. Non-corrosive rubber or synthetic track seals, full track guards, sprocket inner seal guards to provide protection from wire, counterweights to aid in compaction and, in situations where cover material will freeze, a rear-mounted ripper should all be considered.

Radiator plugging in vehicles is a frequent occurrence in landfilling sites. When radiators are front-mounted, side screens and perforated hoods help prevent engine overheating. Tractors with rear-mounted radiators experience problems less frequently.

ii) Crawler Dozers

Weights commence at about 700 kg. The largest size required is normally obtained. Equipment should include semi-U or full-U mold boards (blades) where large volumes of cover material are to be moved, and special oversized refuse blades when the unit is moving and compacting refuse. Non-corrosive rubber or synthetic track seals, full track guards and sprocket inner seal guards, counterweights, engine side screens and perforated hoods, and rear-mounted rippers (in cold climates) are often specified. The single grouser track shoes which are usually standard equipment on dozers are advisable for compaction work.

iii) Wheel Loaders

Steel guard tires, to prevent flats, are desirable when equipment is working over wastes. Radial tires are often vulnerable to side-wall punctures. Filled tires are sometimes used. Guards can prevent wire from tangling in drive shafts. Multi-purpose buckets add versatility. These loaders can, particularly in small communities, be used for other work such as snow removal, road and sewer construction, demolition, etc.

iv) Tractor Scrapers

These are principally used on large sites. A self-loading scraper is preferred for populations below 300,000 because a pusher tractor may then be unnecessary. The 20 to 25 cubic metre size is popular for larger sites, but if a push-type scraper is used, a larger capacity is recommended. Although scrapers are not normally used directly over wastes, they can provide excellent compaction by repeated passes during the cover operation.

Tractors and scrapers are very versatile; they can dig trenches, transport large amounts of earth, and are fast and dependable. A "strike-off" blade which levels dumped materials may also be used for grading.

v) Motor Graders

Generally, these are used for small road and fill maintenance work; therefore, small equipment is recommended. When they are also to be used on public roads, a larger size is often selected.

iv) Winches

These may be attached to either dozers or loaders. Since an immobile truck can disrupt traffic in the disposal area, a winch for towing may be extremely valuable.

b) Final Selection of Equipment

The method of landfilling and the population served are significant factors. The following is a digest of opinions offered by various experts.

Equipment suggestions:

Population 15,000 - 40 metric tons of wastes per day

(1) Crawler loader - 1 cubic metre

OR

(1) Wheel loader - 1 cubic metre

Population 20,000 - 55 metric tons of wastes per day

(1) Crawler tractor - 1 1/3 cubic metres

OR

(1) Wheel loader - 2 cubic metres

i) Ramp Method

Crawler and wheel loaders are principally used. The former is usually recommended. Wheel loaders are versatile in situations other than landfilling.

Population 40,000 - 110 metric tons of wastes per day

(1) Crawler loader - 2 cubic metres

OR

(1) Wheel loader - 2 2/3 cubic metres

ii) Trench Method

Population 60,000 - 160 metric tons of wastes per day

(1) Small crawler dozer

plus

(2) Self-loading 17 cubic metres tractor scrapers

plus

(1) Larger crawler dozer

OR

(1) Wheel loader with multi-purpose bucket and steel compaction wheels.

The small crawler dozer would spread and compact wastes, while the tractor scraper would excavate an adjacent trench and haul cover material. The larger crawler dozer would spread and compact cover material and grade finished areas. If a wheel loader was used, it could spread and compact wastes while the larger crawler dozer could be used as a back-up.

Population 150,000 - 400 metric tons of wastes per day

(1) Crawler dozer

OR

(1) Self-loading 17 cubic metres tractor scraper

plus

(1) Wheel loader with multi-purpose bucket and steel compaction wheels.

Population 200,000 - 540 metric tons of wastes per day

(1) Larger crawler dozer

plus

(2) Self-loading 17 cubic metres tractor scrapers

plus

(2) Small crawler dozers

OR

(2) Wheel loaders with multi purpose buckets and steel compaction wheels.

iii) Cover Haul Distance

A crawler loader or dozer can carry material economically for about 100 metres, a wheel loader about 200 metres, and a tractor scraper about 1,000 metres.

iv) Future Needs

Although population growth rates are often about 3% per year, reference should be made to official plans. In the past per capital generation rates increased at approximately 3% per annum. This appears to have stabilized, however, periodic monitoring is advisable. Equipment selection should have the capacity to handle at least 25% more than is being generated at the time of purchase.

New, well maintained equipment, should be free from problems for at least two years. However, the site operator must have ready access to standby equipment during his own equipment's downtime.

v) Weather

In freezing weather, site operation will not be difficult providing anticipated weather conditions have been considered and planned for in the winter operational plans. A cab and heater should be provided. Since stockpiled cover material will freeze, a tractor mounted ripper is desirable. Trenches must be excavated and cover stockpiles accumulated prior to freeze up.

In very hot weather, a cab with an air conditioner may be desirable, particularly if equipment is to be continuously in use.

In wet conditions, a cab or canopy is necessary. In extreme conditions, trucks and tractor scrapers may be required to import sand for mixing with regular cover material and gravel to maintain open roads.

4.8.4 Monitoring of Water Quality

a) General Procedures

Designs should be flexible and economic. They should take into account the specific conditions of the site which may be numerous and variable. Consideration must be given to: the hydrogeology of the site, physical properties of the sub-surface materials, nature of the waste deposited in the site, and the specific parameters for which water would be monitored. The part of the contaminant plume being sampled must be known for that sample to yield useful information. Because of these and allied complexities, the number and location of monitoring wells should be determined by a qualified groundwater specialist.

Monitoring wells should include a protective casing, a screening device, and a sanitary seal. These should be selected in accordance with the needs of the particular installation. Monitoring wells must be developed and their response measured before useful water samples can be obtained.

Samples are obtained using specialized sampling techniques. In most cases stagnant water must be removed from the well before sampling. This can be a time consuming process.

b) Testing Parameters

In selecting specific test parameters to determine leachate components, the type of wastes being disposed of must be considered. They may be grouped as follows:

i) domestic refuse;
ii) sludge (sewage);
iii) liquid wastes;
iv) commercial and industrial wastes (solids).

c) Leachate Components

A typical leachate from a landfilling site may be monitored for:

Alkalinity ($CaCO_3$)
Hardness ($CaCO_3$)
BOD (5 days)
COD
pH
Total Suspended Solids
Nitrogen - (NH_3)
Nitrogen - Kjeldahl
Total Phosphates
Sulphate
PCB's

Total Iron
Lead
Mercury
Copper
Zinc
Chloride
Calcium
Potassium
Sodium
Magnesium
Manganese

The above list is incomplete. Parameters to be analyzed will be determined by the types of wastes that are deposited in the site and the purpose of the monitoring. It may be necessary to filter and acidify samples, depending on the circumstances.

4.8.5 Site Staff and Records

Site staff requirements are dependent upon the daily waste quantities and the type of equipment used in site operation. Good design will consider the efficient co-ordination of personnel and equipment.

Good record keeping is an essential element of site operation. Records need not be elaborate, however, they should permit an assessment of costs of operation such as: man hours worked, equipment repair and downtime, cover material used, grading time, litter control, trenching, etc.

Reasons for any particularly high cost can be ascertained, and remedial action taken. In this way, future costs can be predicted and appropriate charges to site users can be set.

4.8.6 Contingency Plans for Winter Operation

a) General

Winter operations require advanced planning for site preparation, staff quarters, equipment maintenance, snow removal, and stockpiling and storage of cover material.

Many problems occur as a direct result of failure to prepare an adequate disposal area in advance of winter. An area sufficient to hold more than the expected volume of refuse should be prepared in advance. Disposal areas for emergency dumping, stockpiles of cover material, areas for piling snow, turning areas for snow ploughs, and snow fences to minimize and control snow drifting, should all be provided and put into place before winter sets in.

Although a well drained area with a southern exposure may normally be chosen for winter operation, the prevailing wind direction should be considered. A sheltered site is preferred over one with exposure to adverse weather fronts. Up to twice the estimated required area for disposal should be prepared so that problems due to heavy snow and equipment failure may be minimized.

Access to ramps and dumping edges should have a slight uphill grade. At sites without continual supervision this is important, since it helps to prevent cars from becoming immobile. Also, site users will not normally drive down an incline to dump for fear of getting mired. With uphill grades to the disposal area, dumping in undesirable locations is minimized.

Sand boxes should be conveniently available in locations where site users may become mired. Again, this is most important at small unsupervised sites.

b) Cover Materials

Fine grained soils such as clays or clay sands cannot be readily excavated and used as cover material in very cold weather. Coarse grain sands or gravel should, therefore, be trucked in and stockpiled. The stockpiles should be protected from freezing by straw and from water by tarpaulins.

The coarser grained materials are usually suitable for winter cover. Sands with a high moisture content may freeze but with reasonable care in the selection of materials and the location of stockpiles this can be avoided. (In Northwestern Ontario, several sites serving populations from 3,000 to 107,000 have operated successfully with temperatures well below -30°C.

A frozen stockpile of sand can form a dangerous "overhang" as the sand is removed. If site equipment cannot remove the dangerous overhang, ditching powder may be used to blast out the hazardous area. This problem should be considered at the pre-planning stage. Explosive storage and trucking facilities for which permits are necessary may be required.

c) Snow Problems

Snow fencing, snow ploughing, snow removal and storage, are typical problems that must be considered. Snow fencing should be placed where local knowledge and experience indicates a need. The protection that hedges and trees provide should also be considered when the winter operating area is selected.

Snow ploughing and the space required to store snow must be considered in advance. The road should allow snow ploughs to operate effectively. A snow disposal area served by a road loop, allows snow to be ploughed away from the waste disposal face. Additional passes can then create

space for both snow disposal and driving. Wide trenches with a slight grade at each end may be constructed for winter operation. The trench can be ploughed along with the road. In this operation, the refuse must be well compacted and covered. Trench operations in clay under extreme climatic conditions may not be suitable due to ponding. During snow melts, it may be necessary to pump out ponded water.

At many sites, snow has to be removed and piled after ploughing. The location of suitable areas for snow storage together with planning for quick and economic snow removal, should be carried out well in advance of winter. In selecting snow storage areas, the melting problems that will occur in spring should be considered. Locations where the melt will flow into the waste disposal area should be avoided. A snow fence around the snow storage area to collect litter after snow melt is useful.

d) Emergency Disposal Areas

At some sites, emergency disposal locations are necessary. Most are close to the entrance. Some act as holding areas when the main disposal face is not in use. These areas should be controlled so that access can be denied when normal operations are resumed. Fencing, gating, and temporary signs are necessary.

e) Equipment Maintenance

In planning site operations, facilities for equipment repair and maintenance, housing of site personnel, lighting, record keeping, hours of operation and daily routines, should all be considered.

A heated garage is required for maintenance of equipment.

A daily equipment check should be performed using a checklist. Waste disposal site operations, particularly in winter, are extremely hard on equipment. Daily maintenance such as removal of wire and paper from rollers, radiators, belly skids, idlers and sprockets is required. The daily checking and maintenance routine normally involves the following:

i) checking belts and liquid levels in radiators before starting;

ii) idling the engine for five minutes before moving;

iii) checking that all rollers are moving;

iv) periodically checking for wire, etc. during each working day;

v) checking the machine completely at the end of each working day;

vi) recording the daily checks made, together with running time and any repairs made.

A winter cab heater is essential if the operator is to function at his best. He can stay on the job longer and accomplish more work.

f) Staff Facilities

Large sites require staff facilities. A minimum requirement may be a heated building, with lunch and washroom facilities. At smaller sites, a building with a space heater, table and few chairs may be sufficient. Some sites have small portable buildings, sheds or trailers which can be relocated to keep them close to the disposal face.

g) Lighting

Because of shortened daylight hours, auxiliary lighting is required. An independent generating system can be used to supply flood lighting for the working area. Such a system can include a gasoline or diesel generator with portable light standards.

The dozer's light can be relocated at a higher level as is normally done on snow ploughs. This is an effective practice at smaller sites, however, it does require modifications to the machine. Alternatively, additional lights may be attached to the roof of the machine.

h) Temporary Signs

It is often necessary to post temporary signs. Printed signs on movable standards should be prepared in advance.

i) Daily Routine

A planned daily routine for maintenance, daily operation, and good record keeping ensures an efficient operation. Good planning gained through experience, is essential in setting priorities in an effort to operate a landfilling operation satisfactorily during adverse weather conditions. As an example, areas should be ploughed according to their priorities. The time required for hauling cover material should also be known in order that haulage can be completed during daylight hours.

j) Spring Clean-Up

Disposal sites may be unsightly in the spring when papers previously hidden by the snow become exposed. Cleaning snow fences and other fencing of debris must be undertaken throughout the winter to reduce this work load in the spring.

k) Hours of Operation and Public Information

Operating hours in winter are often reduced by weather conditions, particularly at smaller sites where the equipment must be used for other work. Some areas have large summer populations but limited winter populations and, therefore, in these cases, short operating days are not a problem. At larger sites, volumes of refuse do not decrease significantly in winter and, therefore, such a reduction is not usually possible. Because of adverse weather conditions, the operators may have to work longer in winter than in summer.

It is usually a matter of a week or two before the public becomes aware of changes in the hours of operation. To prevent dumping at the gate, changes of hours should not be made until the public has been properly informed through the press, radio, notices or any other effective form of media.

4.8.7 Designation of Special Disposal Areas

a) Winter Disposal and Stockpiling Cover Material

See Section 4.8.6.

b) Special Faces for Segregated Materials

Special faces for disposal of segregated materials should be provided whenever it is practical. The reasons for their establishment include:

- Some materials may have a market value. This should be verified on basis of quotations F.O.B. disposal site face before the face is established. Possible items include metals, tires, cardboard, and papers.

- Some materials may be more expensive to bury than to haul away for re-use, e.g. tires.

- Some materials are hazardous or inconvenient to bury. Oils may be stored temporarily in a container until sufficient quantities are amassed for economic haulage. Logs, brush and wire may be temporarily stored in different areas prior to disposal.

The different disposal areas should be adequately signposted since they will be of little value if the public cannot readily find them.

The faces should be located on a logical basis, in relation to the on-site road network. Road construction should be of a standard adequate for large vehicles to gain access to haul away the segregated materials.

c) On-Site Treatment of Problem Materials

Separate areas may be allocated for the dumping of materials such as appliance bodies (white goods), brush, logs, and wire. However, with appropriate care, these may all be buried in the main disposal face.

- Appliance bodies may be transported on a seasonal basis to the bottom of the main disposal face, crushed, and buried under succeeding cells by heavier equipment.

- Wire fencing, etc. may cause equipment failure by becoming trapped in caterpillar treads and around axles. If it is transported seasonally to the main disposal face and covered with brush and logs prior to compaction, as described above, this hazard will be minimized.

- Logs and brush may be treated as above. Alternatively, they may be placed in well separated piles, in remote areas, not previously used for waste disposal. Provided each pile is not more than 5 metres square and 3 metres high,

is not open to the wind, and is well dried, it may be burned. Illegal smoke emissions should not result. Windless days are preferred for burning as the risk of sparks starting other undesirable fires is minimized.

4.8.8 Burning

Discussions as to whether burning should or should not be permitted at disposal sites usually generate controversy .

Although Ontario Regulation 824 gives no direct guidance, it does call for:

- orderly disposal by compaction and earth cover;
- procedures and safeguards for the prevention of accidents;
- adequate supervision.

Waste management authorities feel that, through these provisions, volume reduction and waste disposal by uncontrolled burning is indirectly prohibited.

a) Methods of Burning

Various types of burning operations are discussed below. Environmental impacts, legislative restrictions, and problems arising from burning are discussed later.

i) Open Burning

This term has been used to describe operations at open sites where all wastes are burned and are rarely compacted or covered. It differentiates these operations from those in covered or closed pits. Ministry approval for open burning is given under special circumstances and is never permitted on a continuous basis.

ii) Pit Incinerators

When located at landfilling sites, pit incinerators needs a certificate of approval in addition to that issued for landfilling. However, the intent to use a pit incinerator must be expressed in the landfilling site application for approval and the landfilling site must be certified to cover such an operation. Incinerators range in character from pits or trenches in the ground to structures designed to promote complete combustion. It is beyond the scope of these guidelines to discuss them in detail. Inquiries about their construction should be addressed to the Ministry's Environmental Approvals Branch.

In its simplest form, a pit incinerator may be a trench at or above grade. More sophisticated units are structures marketed under various trade names. They may provide forced air drafts, ash clean-out mechanisms, spark arrestors, and refractory linings.

In some locations, under ideal conditions and with close supervision, incinerators have had limited success, in that no adverse effects have been observed when selected wastes have been burned. However, the ideal conditions and close control necessary have rarely been sustained for extended periods. Pit incineration has, in the main, been abandoned because of control costs and its failure to meet environmental standards.

Nevertheless, in areas where large quantities of dry wood wastes, such as wastes from a furniture industry, need to be disposed of, pit incineration may be considered. However, the proponent is likely to reject the method when details and costs for its operation are reviewed.

iii) Selected Burning

The burning of dry brush and lumber at small and medium sized sites, is sometimes given qualified encouragement by the Ministry. At larger sites, permission for selective

burning has not been sought, presumably because of costs, aesthetics, and potential fire problems. Brush and lumber should be wind-dried in small piles not more than 5 metres square and 3 metres high and placed at locations designated in the proposals which deal with new sites or with the upgrading of existing sites. Fires should be very hot and the piles relatively small. Combustion should be completed in a very short period of time. In many parts of the Province, a Ministry of Natural Resources Fire Permit is necessary before this Ministry's approval can be considered. In any case, burning at the site should always be carried out under strict conditions and under which normally a Fire Permit would be issued. It is most important that fires be continually supervised and put out before the Supervisor leaves. On windy days, when sparks may be carried to other wastes, crops, grasslands or buildings, burning should be avoided. Ideally, long, dry, windy, sunny periods will precede burning so that the materials to be burned are dry. Fires must not be started using flammables such as rubber, petroleum and asphaltic products because of the dense smoke which is generated.

b) Problems with and Disadvantages of Burning Wastes

i) Health Considerations

Because of the diverse nature of wastes, the certainty exists, that from time to time, hazardous materials will be imported to waste disposal sites. In the presence of heat or fire, explosions or discharge of hazardous contaminants into the atmosphere may result. Workmen, the general public and particularly children may suffer injury as a consequence.

It is very difficult to ensure that fires are completely out. They may be rekindled by ashes and some hot materials and cause further fires, explosions, etc.

Heat and incomplete combustion may affect putrescible, pathological, and hazardous materials. Rapid multiplication of harmful bacteria may ensue or volatile chemicals emitted to atmosphere may cause air pollution problems. Through rodents, flies, birds, and animals, diseases may be transmitted to humans.

Odours caused by the incomplete or protracted combustion of putrescibles may cause harm or material discomfort to persons on or near the site. They may also attract flies and animals and hence accelerate the spread of disease.

ii) Other Aspects

Leachates from the ashes of burned wastes may cause excessive releases or "shock loading" effects on ground and surface waters. Normally, natural decomposition processes permit a gradual release of contaminants, and the natural soil processes and dilution, in these circumstances, are normally sufficient to attenuate the contaminants to non-detectable levels.

Approval of a burning process by the Ministry does not release the proponent from his obligation to comply with Ontario Regulation 15. This Regulation provides that some air emissions constitute an offence under The Environmental Protection Act, 1971. Particulates and gases from combustion processes, which cause "material harm and discomfort" also constitute a violation of the Act.

Burning of wastes may, through wind borne sparks or an underground spread of fire, cause hazards to adjoining property. These risks are obvious in woodland areas. They may also create problems where farming and development takes place adjacent to the landfilling site.

Supervision of fires does not entirely eliminate these risks. However, an even greater risk exists when fires thought to be extinguished break out again after staff have

left and the site is unattended. Under these circumstances, sudden changes in wind direction and velocity may magnify the risk even further.

Volume reductions achieved by burning are rarely greater than those achieved by proper compaction.

The costs of supervising and providing safeguards, where burning is conducted, may exceed those of conventional disposal methods.

c) Advantages of Burning Wastes

Communities with a limited tax base often claim that they cannot afford to purchase or rent the equipment necessary to compact and cover wastes. Burning may prove to be more expensive in the long term when one considers human life, and hazards to health and property. Each case should be considered on its own individual merits. In mosts cases, however, burning will be rejected in favour of a proper landfilling operation when all these hazards are understood.

d) Meetings with Site Operators

Generally, it is the Ministry's experience that if the environmental effects of, and the problems associated with burning are carefully explained to the site operator, the operator will normally tend to move away from waste disposal by burning, to other more acceptable practices. Generally, burning is more a matter of habit than necessity.

e) Summary

Open burning of all wastes received at a landfilling site is normally unacceptable and dangerous. It adversely affects public acceptance of the operation and can jeopardize proper locations for future landfilling sites. The ideal conditions and close supervision necessary for environmentally safe operations can rarely be maintained for extended periods. Selected burning at selected sites can

sometimes be an advantage, if done properly, at smaller sites, providing the following criteria can be met:

- Minimum requirements: compliance with Ontario Regulation 15. If burning is to be permitted and requirements of Ontario Regulation 15 can be met, the following exceptions may be considered:

- Selected material: the burning of selection materials, e.g., dry brush, lumber at small and medium sized sites is permitted only when the site is closed, under strict supervision and the proponent has obtained the necessary fire permits;

- Selected sites: burning of waste at some small sites may be permitted but this should be an exception to the rule. The site must be closed under strict supervision when burning is occurring and the necessary fire permits must have been obtained. The maximum number of times the proponent can burn is once every three weeks.

4.8.9 Fire Fighting and Dust Control

Fire is an ever present risk at a landfilling site when one takes into account the variety of materials, vandalism, mismanagement, and the nature of the waste decomposition processes. Smoke carried beyond site boundaries may cause discomfort to nearby residents and create hazards along highways.

Dust can cause similar problems both on and off the site.

a) Fire Control

At all sites, stockpiled materials should be available to smother fires quickly. It should, however, be recognized that soil blankets may mask rather than solve fire problems.

In addition, it is often desirable to have a pond or reservoir available from which water for firefighting can be drawn. Care should be taken in the design of such ponds that their capacity is adequate and water is accessible in cold weather. The possible extent of fires and the intended pond capacity should be discussed with a person skilled in firefighting. The extent to which firefighting equipment is necessary on-site, and the availablity of local fire agencies to respond should be reviewed.

Occasionally, burning of brush, in areas designated in the site management plan, may be permitted. Only dry material in small piles and located in designated isolated areas should be burned.

The best method of control is prevention. A clean site, without litter and with waste material compacted in cells with earth cover offers few fire hazards. Should fires occur, clean, clear, on-site and access roads will permit a rapid response.

b) Dust Control

Dust carried beyond site boundaries, or even within the site can be a source of annoyance, harm and discomfort both to the public and to site staff.

Prevention, again, is the best control. Soil stripping should be carried out only in areas required immediately as a source of cover material or for waste disposal. Permanent berms should be sodded or seeded immediately and consideration should be given to seeding soil in stockpiles.

Dust problems are apt to occur when winds are high and therefore a contingency plan must be available. Water spraying may be helpful but care should be taken that supplies of water required for firefighting are continuously available.

Problems may also occur due to light winds on unsurfaced roads stirred up by vehicle movement. In these cases, calcium chloride treatment or oil and water spraying can be beneficial. Oil storage in environmentally safe containers is necessary. Guidelines on oils, which may be used for spraying purposes having regard to constituents which are potentially harmful to plant and animal life, are now available.

4.8.10 Litter Control

Refuse should be disposed of in a sanitary, nuisance free manner. If papers and other light materials are scattered about the site, fire hazards and unsightliness result. Litter should be picked up on a regular basis by the site attendant. Unloading should be carefully supervised.

Movable fencing in the unloading area may be of some assistance, however, it should be kept clean to be effective. Once a fence has become clogged, air flow patterns will change and the papers will be carried over the fence. Earth banks or depressions, trees and other natural barriers on the site may provide sheltered areas where normal operations may present minimum or no littering problems. As mentioned previously, depositing the wastes at the bottom rather than at the top of the disposal face can further reduce litter problems.

Littering is more than a simple nuisance problem. It should be treated as a public health hazard.

4.8.11 Vector and Vermin Control

Landfilling sites are attractive places for vectors and vermin to feed and breed. If not controlled, these may present a serious public health problem. The earth cover placed over compacted waste will greatly reduce the presence of vectors and vermin. A minimum of 15 cm of compacted cover material is desirable to control the emergence of

flies. If control by cover material proves to be insufficient, an extermination program should be carried out, conducted by a properly equipped and licensed professional.

4.8.12 Scavenging and Salvaging

Scavenging is defined as the uncontrolled removal of usable materials from the waste. Since this is prohibited, the site should be properly operated to discourage scavenging. The wastes should be covered by cover material at the end of each day's operation. Where site gates are provided, they should be closed during the non-operating hours of the day to discourage entry by unauthorized persons.

Salvaging is defined as the controlled removal of usable materials from the waste. In some special locations, salvaging activities may be permitted at the site; however, manual sorting of the waste for reasons of health and safety should be strongly discouraged.

4.8.13 Landscaping

Normally, final contours, consistent with ultimate intended use, will be planned at the design stage. In many situations, wastes and cover can be compacted such that final levels are developed as each area is worked. Even well compacted wastes will settle because of the nature of the waste and because of decomposition. Allowances for this should be made, bearing in mind the compacted waste densities which can be achieved by the compaction equipment that is used.

The objectives of providing final cover are to prevent wind and water erosion of waste materials and to minimize the rate of surface water incursion into the waste to control gas and leachate production rates. Therefore, final grades should be inspected periodically to determine if settlement or erosion has occurred. Uncovered wastes should be recovered and low spots filled in.

The minimum slope over the finished waste is a function of the type of soil. The heavier the soil, the flatter the finished grades become. (No recommendations are currently available, but North American research studies on this subject are proceeding).

While clay soils are often desirable for final cover, a final dressing of top soil may be necessary to prevent cracking of the clay layer under summer conditions. Further, if clay soils are used, particular attention should be given to gas control design features. Great care should be taken to ensure that necessary site features such as monitoring wells, gas venting trenches, pipes, etc., are not obstructed.

It is perhaps worthy to note that one major disposal area, completed many years ago in the United Kingdom, is now used successfully for crop production. In Ontario, several smaller waste disposal areas have also been returned to agricultural use.

4.9 Site Closure Procedures

The complete closure plan with scheduled dates must be submitted to the Ministry for comment and approval prior to its implementation. Ministry review will ensure that the procedures and timing will provide adequate protection of the environment.

Closure may be considered as having four stages: planning, information and education, implementation, and maintenance.

a) The first step is to ASSESS the problems and PLAN appropriately to ensure that the closure proceeds smoothly in an effort to protect the public and the environment.

b) Providing INFORMATION to and EDUCATION of the public should commence well in advance of site closure and continue through the implementation stage. It usually cannot be terminated until some time after alternative arrangements for waste disposal have commenced.

c) IMPLEMENTATION includes start-up of the new site, a rodent extermination program, grading, compacting, and covering of the old site and the seeding of the site with appropriate vegetation to maintain the integrity of the cover material.

d) The period during which post-closure MAINTENANCE is necessary, is determined by periodic inspection. The integrity of the cover material and side slopes should be checked and, where appropriate, samples should be taken to verify that ground and surface waters have not been adversely affected.

4.9.1 Planning

The basic considerations in planning site closure are the development of the new site and the extermination of rodents followed by closure of the old site.

a) A New Site

If a conveniently located existing site is available, a new site may not be necessary. It should be noted that if the quantity of additional wastes that will go to the alternative site will exceed that produced by 1500 people, an Environmental Assessment Board hearing may be required.

b) Rodent Extermination

Rodent extermination may or may not be required; however, baiting to determine if rodents are present is

always necessary. If they are, extermination procedures, as described under "Implementation" must be carried out.

c) Site Closure

The operator should discuss the necessary procedures fully with Ministry staff. In some situations, where complex problems arise, a consultant may have to be retained.

Closure of some sites will require substantial work. Planning will save both materials and time, and will ensure that the regulations have been met. The erection of fences to restrict access will discourage entry by both humans and animals. Closure should include grading, compacting and the covering of wastes with a minimum of 60 to 100 cm of compacted cover material. The top of the site should be gently sloped to promote runoff. Revegetation should be undertaken to reduce runoff, infiltration, erosion, and to promote evapotranspiration.

4.9.2 Information to and Education of the Public

A public information program will ensure that the closure of a disposal site will be carried out successfully. It will reduce confusion, prevent danger, and reduce closure costs. Dumping at the gate after the site is closed will be minimized. Since human activities always result in waste generation, it is imperative to keep the public informed about the planned closure and the alternative site.

Signs, sometimes, in both of Canada's official languages, should be placed at the entrance and along a perimeter road at approximately 100 metre intervals to indicate that:

a) the site is closed;

b) poisons are being used to eradicate rodents and insects;

c) refuse must be taken to the new location.

Directions to the new site should also be posted and perhaps indicated in pamphlets or advertised through the media.

The public information program can take many forms, from newspaper advertisements, TV and radio coverage, to public meetings. Media announcements should be repeated for about three weeks or whatever period is suggested by persons familiar with local conditions. Whatever methods are used, they must be effective in reaching the public. Any constructive criticism received from the public should be considered since constructive suggestions may save money or time.

4.9.3 Implementation

a) General

There will be few problems if the plan is carefully followed and emphasis is given to the public information program. Covering, grading, compacting and seeding to maintain the integrity of the cover material at the old site should be accomplished as soon as possible after use ceases.

b) Rodent Control

Baiting to determine if rodents are present, and any subsequent rodent extermination procedures should commence well in advance of site closure and final cover procedures otherwise rodent migration to other food sources may occur. Rodent exterminators are required to be licensed by the Ministry and should be requested to provide a 12-month warranty for their work. A typical rodent control program includes the following:

i) Feeding stations are set up to keep rodents at the site, and to establish their food preference to enable the exterminator to determine their

number and identify locations where the poisoned feed stations should be set up. This phase takes two or three weeks.

ii) Foods preferred by rats and spiced with fast acting poisons are placed in the feeding stations.

iii) Fast acting poisons are removed and traps are rebaited with preferred foods spiced with anti-coagulant poisons. This phase lasts three to four weeks.

4.9.4 Maintenance

After a site has been properly closed, subsequent certification is not required. Inspection and maintenance are, however, required by regulation to ensure revegetation and elimination of surface runoff and to maintain the integrity of the cover material.